

aromatics plus thiophene aromatics. These types of molecules have a plurality of side chains available for cracking, and provide higher levels of conversion.

REMARKS

The Applicants submit herewith in accordance with 37 CFR 1.21(b)(1), a copy of the amended paragraphs showing the additions underlined and deletions bracketed in Appendix A.

The amendment at page 2 is of a minor typographical nature that would be apparent to one skilled in the art diligently trying to locate the referenced patent that is part of the background of the invention. The other amendments correct misspelled words.

Accordingly, Applicants assert these amendments do not constitute new matter.

The Examiner is invited to contact the undersigned attorney for the Applicant via telephone should there be any need to discuss this Amendment.

Respectfully Submitted,

Date: _____

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Appendix A

At page 2, lines 5-17:

Heavy oils and bitumens can be upgraded using a range of rapid processes including thermal (e.g., [US 4,490,234;] US 4,490,243; US 4,294,686; US 4,161,442), hydrocracking (US 4,252,634) visbreaking (US 4,427,539; US 4,569,753; US 5,413,702) or catalytic cracking (US 5,723,040; US 5,662,868; US 5,296,131; US 4,985,136; US 4,772,378; US 4,668,378, US 4,578,183) procedures. Several of these processes, such as visbreaking or catalytic cracking, utilize either inert or catalytic particulate contact materials within upflow or downflow reactors. Catalytic contact materials are for the most part zeolite based (see for example US 5,723,040; US 5,662,868; US 5,296,131; US 4,985,136; US 4,772,378; US 4,668,378, US 4,578,183; US 4,435,272; US 4,263,128), while visbreaking typically utilizes inert contact material (e.g., US 4,427,539; US 4,569,753), carbonaceous solids (e.g., US 5,413,702), or inert kaolin solids (e.g., US 4,569,753).

At page 13, lines 24-29:

Furthermore, the liquid products of the present invention may be characterised using Simulated Distillation (SimDist) analysis, as is commonly known in the art, for example but not limited to ASTM D 5307-97 or HT 750 (NCUT). SimDist [analysis] analysis, indicates that liquid products obtained following processing of heavy oil or bitumen can be characterized by any one of, or a combination of, the following properties (see Examples 1, 2 and 5):

At pages 14-15, beginning at page 14, line 22, continuing to page 15, line 23:

The vacuum gas oil (VGO) fraction produced as a distilled fraction obtained from the liquid product of rapid thermal processing as described herein, may be used as a feedstock for catalytic cracking in order to covert the heavy compounds of the VGO to a range of

lighter weight compounds for example, gases (C₄ and lighter), gasoline, light cracked oil, and heavy gas oil. The quality and characteristics of the VGO fraction may be analysed using standard methods known in the art, for example Microactivity testing (MAT) testing, K-factor and aniline point analysis. Aniline point analysis determines the minimum temperature for complete miscibility of equal volumes of aniline and the sample under test. Determination of aniline point for petroleum products and hydrocarbon solvents is typically carried out using ASTM Method D611. A product characterized with a high aniline point is low in aromatics, naphthenes, and high in paraffins (higher molecular weight components). VGOs of the prior art, are characterized as having low aniline points and therefore have poor cracking characteristics are undesired as feedstocks for catalytic cracking. Any increase in aniline point over prior art feedstocks is [beneficial] beneficial, and it is desired within the art to have a VGO characterized with a high aniline point. Typically, aniline points correlate well with cracking characteristics of a feed, and the calculated aniline points obtained from MAT. However, the observed aniline points for the VGOs produced according to the procedure described herein do not conform with this expectation. The estimated aniline points for several feedstocks is higher than that as measured (see example 6; Tables 16 and 17). This indicates that the VGOs produced using the method of the present invention are unique compared to prior art VGOs. Furthermore, VGOs of the present invention are characterized by having a unique hydrocarbon profile comprising about 38% mono-aromatics plus thiophene aromatics. These types of molecules have a plurality of side chains available for cracking, and provide higher levels of conversion, than compounds with reduced levels of mono-aromatics and thiophene aromatic compounds, typical of the prior art. Without wishing to be bound by theory, the increased amounts of mono-aromatic and thiophene aromatic may result in the [discrepancy] discrepancy between the catalytic cracking properties observed in MAT testing and the determined aniline point.

At pages 15-16, beginning on page 15, line 24, continuing to page 16, line 8:

[VGO s] VGOs obtained from heavy hydrocarbon feedstocks, produced as described herein, are characterized as having an aniline point of about 110°F to about 170°F depending

upon the feedstock. For example, using Athabaska bitumen as a feedstock, the VGO exhibits an aniline point of from about 110° to about 135°F, VGO obtained from Athabaska resid exhibits an aniline point of about 148°F, while the VGO obtained from Kerrobert heavy crude is from about 119° to about 158°F. If the VGO is hydrotreated, for example Athabaskan bitumen VGO, using standard methods known in the art, for example, using a reactor at about 720°F, running at 1500psig, with a space velocity of 0.5, and a hydrogen rate of 3625 SCFB, the aniline point increases from about 133° to about to about 158°. Similar hydrotreating of an Athabaska-VGO resid increase the aniline point to about 170°F. With hydrotreating, the API increases, for example, from about 14.2 (for ATB-VGO) to about 22.4 (for Hydro-ATB-VGO), or from about 11.8 (for ATB-VGO resid) to about 20 (for Hydro-ATB-VGO resid), with a decrease in the sulfur level from about 3.7 wt% to about 0.27 wt% (for ATB-VGO and Hydro-ATB-VGO, respectively; see Example 6).

At page 20, lines 1-20:

It is preferred that the reactor used with the process of the present invention is capable of producing high yields of liquid product for example at least greater than 60 vol%, preferably the yield is greater than 70 vol%, and more preferably the yield is greater than 80%, with minimal byproduct production such as coke and gas. Without wishing to limit the scope of the invention in any manner, an example for the suitable conditions for a the pyrolytic treatment of feedstock, and the production of a liquid product is described in US 5,792,340, which is incorporated herein by reference. This process utilizes sand (silica sand) as the heat carrier, and a reactor temperature ranging from about 480° to about 620°C, loading ratios of heat carrier to feedstock from about 10:1 to about 200:1, and residence times from about 0.35 to about 0.7 sec. Preferably the reactor temperature ranges from about 500° to about 550°C. The preferred loading ratio is from about 15:1 to about 50:1, with a more preferred ratio from about 20:1 to about 30:1. Furthermore, it is to be understood that longer residence times within the reactor, for example up to about 5 sec, may be obtained if desired by introducing the feedstock within the reactor at a position towards the base of the reactor, by increasing the length of the reactor itself, by reducing the velocity of the heat

carrier through the reactor (provided that there is sufficient velocity for the product vapour and heat carrier to exit the reactor), or a combination thereof. The preferred residence time is from about 0.5 to about [2sec] 2 sec.

At page 28, lines 21-23:

From SimDist [analysis] analysis, liquid products obtained following multi-stage processing of heavy oil can be characterized by comprising at least one of the following properties:

At page 29, lines 17-18:

The liquid product obtained from multi-stage processing of bitumen may be [characterized] characterized as having at least one of the following properties:

At page 30, lines 10-14

Collectively these results show that a substantial proportion of the components with low volatility in either of the feedstocks have been converted to components of higher [volatitly] volatility (light naphtha, kerosene and diesel) in the liquid product. These results demonstrate that the liquid product is substantially upgraded, and exhibits properties suitable for transport.

At page 34, lines 9-18:

Simulated distillation (SimDist) analysis of feedstock and liquid product obtained from several separate runs is present in Table 5. SimDist analysis followed the protocol outlined in ASTM D 5307-97, which reports the residue as anything with a boiling point higher than 538°C. Other [mthods] methods for SimDist may also be used, for example HT 750 (NCUT; which includes boiling point distribution through to 750°C). These results

indicate that over 50% of the components within the feedstock evolve at temperatures above 538°C. These are high molecular weight components with low volatility. Conversely, in the liquid product, the majority of the components, approx 62.1% of the product are more volatile and evolve below 538°C.

At page 35, lines 1-2:

Table 5: SimDist [anlaysis] analysis of feedstock and liquid product after single stage processing (Reactor temp 538°C)

At page 36, line 1:

Table 6: [Stabilty] Stability of liquid products after single stage processing

At pages 36-37, beginning at page 36, line 17, continuing to page 37, line 3:

These results indicates that undiluted bitumen may be processed according to the method of this invention to produce a liquid product with reduced viscosity from greater than 1300 cSt (@40°C) to about 25.6 - 200 cSt (@40°C (depending on the run conditions; see also Tables 8 and 9), with yields of over 75% to about 85%, and an improvement in the product API from 8.6 to about 12 - 13. Again, as per Example 1, the liquid product exhibits substantial upgrading of the feedstock. SimDist [analysis,and] analysis, and other properties of the liquid product are presented in Table 8, and stability studies in Table 9.

At page 37, lines 5-6:

Table 8: Properties and SimDist [anlaysis] analysis of feedstock and liquid product after single stage processing (Reactor temp. 545°C).

At page 38, lines 1-2:

Table 9: [Stabilty] Stability of liquid products after single stage processing (reactor temperature 525°C)

At page 43, lines 1-2:

Table 12: [Charaterization] Characterization of the liquid product obtained following Multi-Stage processing of Saskatchewan Heavy Oil and Bitumen

At page 43, lines 5-10:

The liquid products produced from multi-stage processing of feedstock exhibit properties suitable for transport with greatly reduced viscosity down from 6343 cSt (@40°C) for heavy oil and 30380 cSt (@40°C) for bitumen. Similarly, the API increased from 11 (heavy oil) to from 15.9 to 18.2, and from 8.6 (bitumen) to 14.7. Furthermore, [yeilds] yields for heavy oil under these reaction conditions are from 59 to 68 % for heavy oil, and 82% for bitumen.

At pages 44-45, beginning at page 44, line 13, continuing to page 45, line 9:

SimDist results indicate that over 50% of the components within the feedstock evolve at temperatures above 538°C (vacuum resid fraction), while the liquid product is characterized as comprising approx 78 to 87% of the product that are more volatile and evolve below 538°C. The feedstock can be further characterized with approx. 0.1 % of its components evolving below 193°C (naphtha/kerosene fraction), v. approx. 1.3 to 4.8% for the liquid product. The kerosene and diesel fractions also demonstrates significant differences between the feedstock and liquid product with 1% of the feedstock fraction evolving between 193-232°C v. 2.8 to 5% for the liquid product, and with 8.7% (feedstock) and 18.9 to 23.1% (liquid product) evolving at this temperature range (232-327°C; diesel).

Collectively these results show that a substantial proportion of the components with low volatility in the feedstock have been converted to components of higher [volatitly] volatility (light naphtha, kerosene and diesel) in the liquid product. These results demonstrate that the liquid product is substantially upgraded, and exhibits properties suitable for transport.

At page 45, Table 14:

Table 14: Properties and SimDist of liquid products prepared from Bitumen following “Two Stage” processing (reactor temp. 538°C; for feedstock properties see Tables 1, 8 and 9).

Fraction	Temp (°C)	R243
Density @ 15.6°C	-	0.9737
API	-	13.7
Viscosity @40°C	-	45.4
Light Naphtha	<71	0.3
Light/med Naphtha	71-100	0.4
Med Naphtha	100-166	3.6
Naphtha/[Kerosne] <u>Kerosene</u>	166-193	1.9
Kerosene	193-232	4.4
Diesel	232-327	19.7
Light VGO	327-360	9.1
Heavy VGO	360-538	41.1
Vacuum Resid.	>538	19.5

At page 46, lines 1-12:

Simulated distillation analysis demonstrates that over 50% of the components within the feedstock evolve at temperatures above 538°C (vacuum resid fraction) while 80.5% of the liquid product evolves below 538°C. The feedstock can be further characterized with approx. 0.1 % of its components evolving below 193°C (naphtha/kerosene fraction), v. 6.2%

for the liquid product. The diesel fraction also demonstrates significant differences between the feedstock and liquid product with 8.7% (feedstock) and 19.7% (liquid product) evolving at this temperature range (232-327°C). Collectively these results show that a substantial proportion of the components with low volatility in the feedstock have been converted to components of higher [volatitly] volatility (light naphtha, kerosene and diesel) in the liquid product. These results demonstrate that the liquid product is substantially upgraded, and exhibits properties suitable for transport.

At page 46, lines 29-30:

For hydrotreating the [Athabsaca] Athabasca bitumen VGO, the reactor conditions were as follows:

At page 48, line 4:

Table 16: [Microcativity] Microactivity Testing (MAT) results

At page 52, Table 17C:

Table 17C: Calculated Analine Point on a vol% basis, continued

	ATB-VGO (255) Vol% FF	Hydro-ATB- VGO (255) Vol % FF	ATB-VGO resid Vol % FF	Hydro ATB- VGO resid Vol % FF
Fresh Feed Rate:	68.6	68.6	68.6	68.6
Riser Outlet [Temperatyre] Temperature °F	971	971	971	971
Fresh Feed Temperature °F	503	503	503	503
Regenerator Temperature °F	1374	1238	1345*	1345*
Conversion	60.86	75.29	83.82	72.34
C2 and Lighter	6.13	3.36	4.80	4.13
H2S	1.42	0.12	1.55	0.04
H2	0.14	0.17	0.18	0.60
Methane	1.85	1.13	1.43	1.56
Ethylene	1.10	1.04	0.48	0.79
Ethane	1.63	0.89	1.17	1.14
Total C3	7.54	10.44	7.66	8.49

At page 54, lines 3-11:

These results indicate that VGOs prepared from liquid products following rapid thermal processing as described herein (e.g., ATB-VGO, KHC-VGO and Hydro-ATB-VGO) are substantially different from VGOs obtained from similar feedstocks that have been only processed using conventional methods (e.g., distillation), for example ANS-VGO. Further analysis of the above VGOs obtained following rapid [therml] thermal processing indicates

that they are characterized by having a unique hydrocarbon profile comprising about 38% mono-aromatics plus thiophene aromatics. These types of molecules have a plurality of side chains available for cracking, and provide higher levels of conversion.